

September 5, 2003

MEMORANDUM FOR: William A. Stone  
NGS Advisor to New Mexico

FROM: Charles W. Challstrom  
Director, National Geodetic Survey

SUBJECT: INSTRUCTIONS: NEW MEXICO FBN REPLACEMENTS  
SURVEY (GPS-1903)  
Task Number: A8K6D20P00 (FBN)

GENERAL:

The National Geodetic Survey (NGS), in accordance with NGS policy, will be coordinating the re-establishment of two Federal Base Network (FBN) stations and five Cooperative Base Network (CBN) stations in the state of New Mexico.

FBN stations GRANTS AIR and SANTA AIR have been reported destroyed and will be replaced by stations TOLTEC and SANTA FE CBL 0, respectively. Five CBN stations will also be established in the two areas.

The New Mexico Department of Transportation will perform the observations and provide the observations, logsheets, rubbings, observation diagrams, etc. NGS will perform the processing.

The project coordinator is Mr. Bill Stone , NGS Advisor.

PURPOSE:

In order to meet America's accelerating positioning and navigation needs, the existing coordinate reference system must be continually enhanced to provide the accessibility and high accuracy required for use with GPS. The digital revolution in mapping, charting, and surveying requires a National Spatial Reference System (NSRS) consisting of, among other components, a network of monumented points having four-dimensional positions. The FBN fulfills the requirements for this component. NGS is charged with the Federal responsibility for the establishment, observation, monitoring, and maintenance of the FBN. The FBN provides the critical network foundation for an accurate, consistent, reliable NSRS.

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The NSRS, in turn, provides the common geographic framework for America's spatial data infrastructure. As such, the NSRS serves as the basis for mapping, charting, navigation, boundary determination, property delineation, infrastructure development, resource evaluation surveys, and scientific applications, including crustal motion monitoring, modeling of flooding, storm surge, pollution trajectories, and agricultural runoff. A modernized, accurate, consistent, reliable NSRS is of enormous benefit to state, county, tribal, local, and Federal authorities, as well as to the private sector.

### SPECIFICATIONS:

Project requirements for the FBN and CBN observations are to ensure 2-centimeter local accuracy in the horizontal component, as well as 2-centimeter local accuracy for the ellipsoid heights.

Data from CORS in the region are to be used in the processing. There are 11 National CORS to choose from. There are seven in New Mexico and two each in Colorado and Arizona.

The seven in New Mexico are: Aztec (AZCN), Santa FE (NMSF), Tucumcari (TCUN), White Sands (WSMN), PIE TOWN (PIE1), Albuquerque USCG 1 (ABQ1), and WAAS site Albuquerque WAAS 1 (ZAB1).

The two in Colorado are Granada (GDAC) and Pueblo (PUB1). Lastly, the two in Arizona are Tucson (COT1) and Globe (AZGB).

General specifications for the project are as follows. At each FBN and CBN site, three sessions of 5-1/2 hours duration for each session shall be observed. The observing scheme shall be arranged so that for each station, the start time of one of the observing sessions shall be at least 4 hours different from the other two.

In general, station occupation and observing procedures must be carried out according to appropriate sections of the "NGS Operations Handbook" and the current applicable receiver field manuals. Data formats and digital file definitions are given in "Input Formats and Specifications of the National Geodetic Survey Data Base," Volume I. Horizontal Control Data, Federal Geodetic Control Subcommittee, September 1994, revised and reprinted November 1998. Success in meeting the accuracy standards will be based on repeatability of measurements and adjustment residuals.

General specifications for the project are given in "Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques," Version 5.0: dated May 11, 1988, and reprinted with corrections August 1, 1989. Specific project criteria are given in the following section.

Project Network - A list (Table 1) and sketch of stations involved in this project will be provided.

Data Acquisition - Data collection must be accomplished as specified in the appropriate dual-frequency receiver field manuals in the compressed mode at a 15-second epoch collection interval. The GPS receivers must be dual-frequency and full-wavelength. Track satellites down to a 10-degree elevation angle.

Sessions will generally begin at two observing windows 4 hours apart for the GRANTS AIR area - 1400 and 1800. (The Santa Fe area observing windows will be determined shortly.)

Vectors between the project stations shall be measured by single sessions consisting of continuously and simultaneously tracking for 5-1/2 hours.

Each FBN and CBN station must be occupied at least three times - twice at one observing window and once at the other. Each FBN and CBN station must be tied to two different bench marks. This bench mark tie requirement can be satisfied in one or two sessions. CORS data will be used throughout the project.

Record weather data just before, immediately after, and at the mid-point of each session. Meteorological data shall also be collected immediately after an obvious weather front passes during a session and immediately before it passes, if possible. Pressure and relative humidity measurements must be made near and at about the height of the GPS antenna phase center. Indicate in the log the location of the barometer and psychrometer.

Survey operations shall be conducted with due regard to the safety of personnel and equipment. Contact with the airport traffic control tower is mandatory during surveys at any controlled airports.

Vector Computations - Data management, quality review of collected data, and final vector processing for the FBN replacement survey will be accomplished by the Project Development Branch, N/NGS21, using PAGES. Vectors shall be computed in the International Earth Rotation Service Terrestrial Reference Frame (ITRF) system, using the most current epoch and precise IGS ephemerides. Use 30-second epoch intervals for data processing. Monument positions will be used for CORS when available, otherwise, antenna reference point (ARP) positions will be used.

The data will be processed in 24-hour sessions (or slightly longer if the observation session crosses 0000 UTC) in order to utilize the 24-hour data sets collected at the nearby CORS. The "fixed baseline" option in PAGES will be used to compute direct baselines between the CORS. The "fixed baseline" scheme will depend on the location and reliability of the CORS used in this project.

For stations where weather data are not available, or are suspect, predicted values computed in PAGES based on the station's latitude, height above mean sea level, and time and day of year will be used. Use 15 degrees as the cutoff elevation angle in data processing. A cutoff angle of 10 degrees may be used when necessary to improve results.

The type of final solution, L1 versus ion-free, will depend on the length of the vectors. For vectors which are less than 10 km in length, the final reduction will consist of a L1 fixed solution. These vectors will be computed in a separate processing session from the longer vectors computed in an ion-free solution.

In general, vectors greater than 10 km in length are to be computed in an ion-free fixed, or partially-fixed, solution. In all cases, integer ambiguities will be fixed for each vector whenever possible. The quality of collected data shall be determined from the plots generated from PAGES, by analysis of repeated vectors and/or comparison of station positions, and free adjustment residuals and/or loop misclosures. In addition, a constrained adjustment constraining all CORS will be performed.

NGS will perform all quality checks for conformance with NGS format standards such as executing software programs COMPGB, OBSCHK, and OBSDES. The final ITRF vectors will be assessed and transformed to the NAD 83 coordinate system using program ADJUST.

The data and results will be submitted to the Observation and Analysis Division. All B-files and G-files must be complete, including \*25\* and \*27\* records.

Station Descriptions - Station recovery notes must be submitted in computer-readable form using DDPROC software. Include the name, address, and, if public ownership, the telephone number of the responsible party. Do not include the telephone numbers of private property owners. Bill Stone will provide the descriptions.

Special Requirements - Antenna set-up is critical to the success of this project. Fixed-height tripods are preferred for all receivers. The plumbing bubbles on the antenna pole of the fixed-height tripod must be shaded when plumbing is performed. They must be shaded for 3 minutes before checking and/or re-plumbing. Also, the perpendicularity of the poles must be checked at the beginning of the project and any other time there is suspicion of a problem.

When a fixed-height tripod is not used, the height of the antenna must be carefully measured to prevent station set-up blunders from occurring. Tribrachs used for these set-ups must be checked and adjusted when necessary. Totally independent measurements of the antenna height above the mark in both metric and English units must be made before and after each session. Someone other than the observer must check the measurement computations by carefully comparing measurements and then entering his/her initials on the log. Some GPS antennas have detachable ground planes and radomes. In order to help identify what exactly was used at a particular site, it would be useful to have a snapshot of the setup. All co-observers should take a photograph of the setup, if possible, with a close-up of the antenna as viewed from the side.

In addition, a rubbing of the stamping of the mark must be made at each visit to a station. If it is impossible to make a rubbing of the mark, a plan sketch of the mark must be substituted, accurately recording all markings.

In addition, digital photographs of each survey mark are required. See "Requirements for Digital Photographs of Survey Control," Version 10, for specific information.

Also, for each station visited, a visibility obstruction diagram must be prepared and the TO-REACH description carefully checked for errors or omissions.

Lastly, the following must be recorded at each occupation of a station:

- (1) receiver manufacturer,
- (2) antenna manufacturer,
- (3) receiver model number (part number),
- (4) antenna model number (part number),
- (5) the complete serial number of the receiver, and
- (6) the complete serial number of the antenna.

Success of this project requires that the highest quality GPS data be collected. Therefore, during each station occupation, the operators shall carefully monitor the operation of the receivers. Any irregularities in the data due to equipment malfunction, DOD adjustment of the satellite orbit, obstructions, etc., must be reported to the Project Development Branch, N/NGS21, as soon as possible and noted on the observing log. If the quality of observations for an observing session is questionable, notify the Project Development Branch immediately.

#### GPS DATA:

Visibility tables and plots of the present satellite constellation for August 19, 2003, have been reviewed and two observing windows selected. (This observing window was just determined for Part 1 of the project - the replacement of GRANTS AIR. The SANTAIR observing windows will be determined shortly.)

For operational use, current data must be generated with Trimble mission planning software or from program SATMAP.

Project report and data listed in Annex L of "Input Formats and Specifications of the NGS Data Base" and in the attached addendum for the adjustment portion must be transmitted. Any data considered suspect as to quality in achieving accuracy standards should be sent via FedEx immediately for office review. Backup of transmitted data must be held until notified by the Project Development Branch, N/NGS21.

The data set collected during the project shall be named "nmre083d.1178". All records in connection with this project shall be titled "NEW MEXICO FBN REPLACEMENTS SURVEY". The project number (accession number) is GPS-1903.

LIAISON:

Liaison must be maintained with designated offices at the National Geodetic Survey headquarters located at:

1315 East-West Highway  
Silver Spring, Maryland 20910-3282

Questions and problems concerning adjustment processing should be directed to:

Maralyn L. Vorhauer  
Observation and Analysis Division  
N/NGS4, SSMC III, Station 8562  
Telephone: 301-713-3176, ext. 104  
Fax: 301-713-4327  
e-Mail: Maralyn.Vorhauer@noaa.gov

Questions and problems concerning using CORS data in processing should be directed to:

Miranda Chin  
Geosciences Research Division  
N/NGS6, SSMC III, Station 9111  
Telephone: 301-713-2844, ext. 125  
Fax: 301-713-4475  
e-Mail: Miranda.Chin@noaa.gov

Questions and problems which could affect the technical adequacy of the project should be directed to:

Stephen J. Frakes (Douglas R. Hendrickson)  
Chief, Project Development Branch  
Spatial Reference System Division  
N/NGS21, SSMC III, Station 8853  
Telephone: 301-713-3194, ext. 111 (ext. 127)  
Fax: 301-713-4316  
e-Mail: Steve.Frakes@noaa.gov (Doug.Hendrickson@noaa.gov)

The coordinator for the FBN observations is:

Mr. William A. Stone  
New Mexico State Geodetic Advisor  
National Geodetic Survey  
P.O. Box 1293  
C/o Public Works - Survey Section  
Albuquerque, NM 87103  
Telephone: 505-768-3606  
Fax: 505-768-2502  
E-mail: William.Stone@noaa.gov

Names and telephone numbers of local contacts are given in the station description material.

ADDRESS:

Keep N/NGS21 informed of the party's physical address and telephone number at all times.

PUBLICITY:

See "NGS Operations Handbook," Section 1.4.1.

EXPENSES:

FBN expenses for this project will be charged to task number A8K6D20P00.

TRAVEL:

Travel and per diem are authorized in accordance with Federal Travel Regulations, Part 301-11, Per Diem Allowances. Current per diem rates were effective October 1, 2002.

ACKNOWLEDGMENT:

Please acknowledge receipt of these instructions in your Monthly Report.

cc: N/NGS - D. Zilkoski\*  
N/NGS - S. Misenheimer\*  
N/NGS1 - G. Mitchell  
N/NGS1x1 - W. Stone  
N/NGS11 - S. Cofer  
N/NGS21 - S. Frakes  
N/NGS21 - R. Anderson  
N/NGS21 - D. Hendrickson\*  
N/NGS22 - T. Soler  
N/NGS3 - E. Allen  
N/NGS4 - E. Wade  
N/NGS4 - M. Vorhauer  
N/NGS4 - D. Hoar  
N/NGS41 - W. McLemore  
N/NGS41 - J. Blackwell  
N/NGS5 - R. Snay  
N/NGS6 - M. Chin  
FGCS Members\*

\* first page only



**DATA TO BE SENT TO HEADQUARTERS RELATING TO  
THE ADJUSTMENT PORTION OF  
FBN REPLACEMENT PROJECTS**

Free adjustment in NAD 83 (UNIX run).

Plots of the free adjustment created by running “plotres\_prompt.bsh” on a UNIX server. Plots require a printer that supports postscript. The output file (long.out) contains a list of residuals which may be sorted using the following commands:

```
vi long.out
:1,$ !sort +0.47 (sorts horizontal residuals)
:1,$ !sort +0.71 (sorts vertical residuals)
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(OPTIONAL) Constrained horizontal adjustment holding NGS CORS positions and ellipsoid heights.

Final combined Blue Book file (ASCII required) with \*86\* records (GEOID99).

Final description file (ASCII required.)

Final G-file (ASCII required.)

OBSCHK output.\*

CHKDDESC output.\*

OBSDES output.\*

\*Any errors or warning messages must be explained.